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by

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The Occasional Papers of the Southern Forest Experiment Station present information on current southern forestry problems under investigation at the Station. In some cases these contributions were first presented as addresses to a limited group of people, and as "occasional papers" they can reach a much wider audience. In other cases, they are summaries of investigations prepared especially to give a report of the progress made in a particular field of research. In any case, the statements herein contained should be considered subject to correction or modification as further data are obtained.

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At one time or another almost every man in charge of a planting operation faces the necessity of studying the effect of various factors upon initial survival [1/] of the planted trees. Such studies are particularly likely to be needed when changes in nursery practice, planting tools, or available labor cause a change in the general method of planting; when a new species is added to the list of those planted; when planting is extended to a new territory; or when a review of accounts shows an unduly high cost per thousand trees established. Often, however, the demand for such studies arises at the height of the planting season, when the men in charge have scant time to devise experiments. In addition, the men may have had relatively little experience in investigative planting. As a result, the numbers of trees used in the studies may be either too small for reliability or too large for efficiency, or flaws in arrangement of the plots may cause variations in soil to make insignificant factors appear important or significant ones appear negligible.

This paper describes a method of laying out plantations and of recording survival counts which the Southern Station has found particularly well adapted to the study of most of the factors affecting survival. The method, which requires that the plantations be laid out in what are known as "balanced, randomized blocks", is based on one developed largely by R. A. Fisher. Although at first glance it appears considerably more complex than the old-fashioned "plot and check-plot" studies, or than plantations of two treatments in alternate rows, it is actually very easy to apply if the directions given here are followed step by step. The little extra trouble involved is more than offset by the greater economy of planting and increased dependability of results. These advantages are attained by the internal arrangement of the experimental plantations, which largely eliminates the disturbing effects of irregular moisture supply, variations in soil, and differences in competing vegetation, and which makes it possible, by planting a relatively small number of trees, to measure accurately the net effect of the different treatments being studied.

1/ Initial survival may be defined as that shown by the planted stock after the occurrence of the mortality more or less directly brought about by the whole process of planting, including the environment chosen for the planted trees. It is usually best measured at the end of the first growing season, but in special cases supplementary measurements may be desirable about the first week in June of the first growing season and at the end of the second or third growing seasons. A study of initial survival should not include effect of epidemics, insect infestations, or droughts after the planted trees are well established, and of course never includes later losses arising from competition as the crowns close.

Many modifications of the method are possible, but unless the planter is an experienced statistician, it is suggested that he follow strictly the application described here, lest he weaken his results or make them entirely unreliable.

Material and Equipment Required

In addition to the necessary planting tools and planting stock, the following materials and equipment will be required to carry out the study; much time and annoyance (and possibly serious errors in the work) can be avoided by preparing them in advance.

1. Office equipment:

   a. A set of wooden "lotto" or "bingo" numbers running from 1 to 60 or higher, for randomizing. They can be obtained at almost any 5- and 10-cent store. Other numbered objects, such as slips of paper or flat metal tags, can not be mixed thoroughly in a reasonable time and should not be used.

   b. A tin can with straight sides, or a cylindrical oatmeal box, for shaking up the numbers.

   c. One establishment report diagram (form 1) for each block. This form is more convenient if typewritten.

   d. One establishment report summary (form 2) for every four blocks. This also should be typed if possible.

   e. One field examination record (form 3) for each examination of each treatment; as a relatively large supply of these forms is involved, mimeographing them is recommended rather than typewriting.

2. Field equipment:

   f. Large, durable corner posts sufficient to mark "block" corners.

   g. Enough small, durable stakes--2 feet is a good length--to mark each end of every row.

   h. At least one measuring cord, 26 times as long as the distance between one tree and the next in the plantation. From two to eight cords will be needed in large studies. Each cord must have a loop at each end to be slipped over the stake at each end of the row, and must be marked at equal intervals, with paint or tags, to show where 25 trees are to be planted in the row, at the spacing chosen. (A spacing of 5 feet between trees and between rows is suggested, as it reduces the size of the plot and makes it easier to find trees on re-examination, but 6 x 6 feet or any other moderately close spacing will serve.)

Size and Arrangement of the Plantation

At any given spacing, the area required for an experimental plantation depends upon the number of treatments to be tested. The method described here is flexible enough to permit from 10 to 60 different treatments in one experiment. It is best adapted, however, to testing 16 to 30 treatments at once. Actual practice has shown that studies of less than 10 or more than 60 treatments made as described in this paper are generally inefficient and lack desirable precision.

The plantation layout has been developed to test each treatment by means of 100 trees. The total number of trees in a study, therefore, equals 100 times the number of treatments. These trees are planted in four blocks of identical size and shape, laid out as follows:

The length of each block is 26 times the distance between two consecutive trees in the row, that is, long enough to accommodate rows of 25 trees each. The width of each block is obtained by adding 1 to the number of treatments to be tested, and multiplying this sum by the distance between two adjacent rows, which should be the same as that between two trees in a row. For 20 treatments spaced 5 x 5 feet, there would consequently be required 4 blocks each 130 x 105 feet.

These four blocks should be laid out on as uniform a site as possible. Furthermore, it is especially important that conditions within each block be uniform; if the site as a whole shows differences that cannot be avoided, the blocks should be laid out so that there is less difference between two parts of any one block than between two blocks each taken as a whole.

On a fairly uniform site the blocks should be laid out end to end in a rectangle; this arrangement has the advantages of simplifying work and saving stakes. On a site marred by small drainage ways, areas of strikingly different soil, or patches of heavy brush, these advantages should be sacrificed and the blocks separated to exclude the disturbing factors; this precaution is necessary to maintain the comparability of rows within each block. The greatest gap between blocks ordinarily should not exceed 100 feet.

When the corners of the four blocks have been established, the next step is to drive stakes at the ends of the blocks, at the spacing decided upon, to mark the beginning and end of each row. The blocks should then be given the designations A, B, C, and D (or other convenient designations), beginning with the block farthest from the road or other avenue of approach. Each series of stakes marking the ends of the rows should be numbered from 1 to 20 (or whatever the number of tests is), with the numbers running from left to right. (Paint, metal tags, or a good, permanent grade of lumber keel may be used to mark the row stakes.)

This system of lettering and numbering is suggested because, as one approaches the plantation from the road gate, it makes an orderly arrangement of block letters, row numbers, and tree numbers, running in the same direction as the writing on a sheet of paper (fig. 1). As will be seen in the sections on planting and on re-examination, ease in finding any particular row is essential to efficient use of the method.

Arrangement of Tests Within Blocks

The blocks can be laid out in the field, staked, and numbered as soon as it has been decided how many methods are to be tested and what spacing is to be used. Before the actual planting can be done, however, the arrangement of tests within blocks must be determined. As the method of experimental planting under discussion depends for its success entirely upon this arrangement, the following directions must be followed exactly:

1. List the treatments to be tested, for example, 20, in any convenient order on form 2, and number them from 1 to 20, as in the example on page 15.

2. Take lotto numbers 1 to 20 and place them in a cup.

3. Take a copy of form 1 and head it for block A, as in the example on page 13.

4. Shake the lotto numbers thoroughly and blindly draw one from the cup without exercising any choice in any way. Copy this number in the second column on form 1, opposite row number 1. Lay the drawn number aside; do not return it to the cup.

5. Draw the rest of the numbers and copy them in the second column of form 1, opposite row numbers 2, 3, 4, etc., laying each aside as soon as copied. This process gives the order in which the various treatments (20 rows of 25 trees each) will be arranged in block A, and in block A only.

6. Head a second form 1 for block B, replace the lotto numbers in the can, shake thoroughly, draw the numbers at random as before, and copy, as drawn, in the second column, to give the order of treatments in block B.

7. Repeat the process for block C; also for block D.

8. Now turn again to form 2, which gives the nature of the treatment corresponding to each treatment number. Using this as a guide, enter the nature of the corresponding treatment opposite each treatment number that has been entered on form 1 for block A, for block B, etc. Form 1 for each block thus becomes a diagram, from which the actual method under test in any row can be read at any time; the row number can of course be read instantly from the stake at the beginning or end of the row.

9. While entering on form 1 the nature of treatment read from form 2, enter also on form 2, in the appropriately lettered column, the number of the row in which that treatment is being tested in the block. This makes of form 2 a cross-index to the location of treatments — an index which is invaluable not only in supervising and checking the work of planting but also in making out the forms for later survival counts.

A word of caution is necessary concerning the process of selecting at random the rows to which the various treatment numbers are assigned. Each block in each experiment must be randomized afresh. Except in the rare event that an identical arrangement appears by chance, the same arrangement must not be used twice, either in the same study or in different studies. If it does appear by chance, it must be used, because the numbers must be accepted

as they fall. The person arranging the layout may no more reject a series of drawn numbers "because he doesn't like the looks of it" or because it resembles or duplicates a previous series, than he may substitute a systematic arrangement of tests for the random arrangement upon which the ultimate success of the method depends. If lotto numbers of uniform size are used, and if they are well shaken in a cup that is large enough to permit free movement, the experimenter may feel confidence in such randomizations, which are absolutely essential to the measurement of the precision of results obtained in the study.

Establishment of the Plantation

The following precautions must be observed in the actual establishment of the plantation, lest disturbing factors enter in and obscure the effects of the treatments to be tested.

1. Except in a test of season-of-planting, or of weather-at-time-of-planting, all four blocks should be planted in one day. If they are not, some of the stock will be subjected to one set of weather conditions (risk of drying out, etc.) and some to another. In fact, a week of bad weather intervening between two planting days may seriously derange the experiment. In the example cited on forms 1 and 2, involving method and duration of storage, the stock should be lifted at 5-day intervals and planted all in one day, instead of being lifted all in one day and held for progressively longer periods.

2. It is best if one man (or one pair of men working together) plants all four blocks. If the number of treatments to be tested makes this impossible within the limit of one day, two men (or two pairs) should each plant two blocks, or four men (or pairs) should each plant one block. Two men should never divide the work on any one block.

With the treatments given on forms 1 and 2, for example, one man should not plant all the heeled-in stock and another all the baled stock, because, if the baled stock showed poorer survival, it would be impossible to tell whether losses were the result of baling or of poor planting by one man. Similarly, if one man plants both heeled-in and baled stock on blocks A and B, and a poorer planter plants both stocks on blocks C and D, and if blocks C and D show a low average survival for all treatments, it will be impossible to tell whether the losses on blocks C and D were caused by poor planting or by poor soil on those blocks. This, however, is not important, as the study is of treatments, not of planters or plots of ground, and those particular blocks (and probably also the particular planters) will never be used again. The important thing is that stock from each storage method (heel-in and bale) be equally exposed to both good and bad soils and to good and bad planting so that the true differences between the storage methods, if any, will be brought out.

3. Even at the expense of extra walking and loss of time, it is usually better to plant treatments in numerical order, and to complete each on all four blocks before going to the next treatment, than to plant row 1, row 2, etc., of each block consecutively. The example on forms 1 and 2 illustrates this point clearly. If the bale for treatment no. 2 is opened to plant row 7 of block A, and left open during the planting of rows 8-20 in block A, all of

blocks B and C, and several rows in block D, the stock drawn from this bale for the appropriate row in block D may have been very seriously affected by changes in temperature and moisture. Figure 1 shows the logical progress of planting, through the planting of the first 175 of a total of 2,000 trees.

With these precautions in mind, the simplest way to supervise a small experimental planting is to give one man a measuring string (or, preferably, four strings) and the form 1 for all four blocks, while a second man (or pair), equipped with the necessary tools, gets the stock for each treatment in turn, under the direction of the man in charge. It is advisable to <u>count the stock into four groups of 25 trees each before distributing to the planter, labeling each group</u> with block, row number, and treatment number, read from form 2 by the man in charge.

The man with the marking string glances down the second column of form 1 for block A, sees that treatment 1 is to be planted on row 2, and accordingly stretches a measuring string from the no. 2 stake on the far side of block A to the no. 2 stake on the near side. Then the planter, or pair of planters, plants one tree at each mark on the string and tucks the label from the bundle of trees into the grass at the foot of the stake at the far end of the row. Meanwhile the "string-man" goes to block B and stretches a string between the appropriate stakes (marking row 17), shown by the position of treatment no. 1 in the second column of form 1 for block B.

Even on the largest studies, with four blocks of 60 rows each, the same system works. A study of this size, however, requires four planters (or pairs); each block then requires one planter, a string-man, two strings, and, if possible, a carrier to relieve the planters from walking back and forth with supplies of stock. Under this arrangement, the string-men carry the copies of form 1 for their respective blocks.

The Southern Forest Experiment Station, working on blocks laid out as described with a crew of 13 experienced CCC enrollees (4 string-men, 4 planters, 4 carriers, and 1 tree-counter to assist the officer in charge) and using 8 strings, has planted 7,200 trees in 5 working hours, without undue haste. The stakes, of course, had all been driven and numbered in advance.

Each string-man, as he finishes stretching a string, should check off both row number and treatment number, in pencil, on form 1. When the planting has been completed, the man in charge of the work should go along each row of stakes, picking up the labels removed from the groups of trees and checking the stake number and label against form 2. If any error has occurred, forms 1 and 2 should be corrected to show the actual location of the treatments on the ground, as these forms are an essential part of the record and constitute the guide to re-examination.

Forms 1 and 2, completely filled in, together with a map showing the location of all the blocks, and with descriptions of the stock (including seed source), planting site, weather during planting, and treatments being tested, constitute all the establishment report needed.

Type of Survival Study to Which the Foregoing Layout is Particularly Adapted

The layout just described is especially adapted to the study of factors affecting the individual tree rather than the entire planting site. Such factors are the species, age, class, grade, health, or size of the planting stock; its treatment by cultivation, fertilizing, shading, or watering in the nursery; root pruning during the growing season or at lifting time; mechanical injury or exposure during lifting or planting; method or duration of storage of planting stock; season of planting; depth of planting; tool used; localized site preparation, such as plowing of furrows or hoeing of spots; control of pests by various sprays; and control of drought injury by shading, mulching, coating with oil, or pruning the needles. Most survival studies involve just such factors.

The layout of four balanced blocks, each with treatments randomized by 25-tree rows, is not adapted to studies of the effect of treatments applied to the site as a whole rather than to the individual tree. Such studies include eradication or control of animals, insects, or diseases by scattered baits, poison applied to burrows, or removal of alternate hosts; control of competing brush large enough to exert its influence beyond the width of a row; preparation of the entire site, as by burning or by complete plowing and harrowing; and effect of soil type or topography. It is obviously impossible to get typical burns on single rows, or to arrange ridges, slopes, and draws according to the chance order of the lotto numbers. For studies of this kind special techniques must be developed.

In choosing the treatments to include in one study, that is, in one set of four blocks, care must be taken to compare similar things. Except as noted in the following section, <u>any one study should be confined to variations of one factor</u> (such as root length, storage, or planting tool), <u>or should test several complete planting systems</u> such as have been developed and found effective in different territories. A study should not include comparisons between "date of planting" and "2-year-old stock", or between "seedlings fertilized in nursery" and "seedlings heeled-in for 40 days"; such miscellaneous comparisons are meaningless.

Special Cases

A modification of the general method very greatly increases the effectiveness of the layout in many instances, especially if the number of available treatments (for example, tools, or root lengths) falls below 15. This modification involves applying <u>each</u> of several original treatments (perhaps 10, as in the case of tools) to <u>each</u> of two species, or to <u>each</u> of two ages or grades of planting stock. The combination of several original treatments with two species is especially effective; in fact, three or even four species may sometimes be used to advantage.

In applying this modification, each combination of original treatment (such as tool) with species constitutes a separate final treatment. For example, 10 tools tried simultaneously with longleaf and slash pine would give a total of 20 treatments to randomize over each block, with each tool represented by 50 trees (25 longleaf and 25 slash) on each block, and each species by 250 trees (25 for each tool) on each block.

There are two advantages of this special modification: One is that it makes it possible to test a limited number of original treatments (such as 10 tools) and still bring the number of rows in each block within the range (16 to 30) which appears most effective; the other is that it brings to light any differential response of species (or age or grade of stock) to treatment. One tool, for example, may work well with longleaf and poorly with slash pine, or the shortest permissible root length for one species may differ by 2 or 3 inches from that for the other. Such information is extremely valuable in determining planting policies and in supervising routine commercial planting of either species.

Re-examination of the Plantation to Record Survival

Re-examination of the plantation, apparently complicated by the random arrangement of treatments in each block, is actually very simple, provided only that the numbers on the stakes marking the rows are distinct and that form 2 is correctly made out. The ease of examination results from the use of form 3, [2] one copy of which is needed for each treatment being tested.

To prepare the forms for re-examination, enter at the head of the first copy of form 3 the study, species, and nature of treatment for treatment no. 1, taken from form 2 as made out when the plantation was established (see pages 4 and 15). At the tops of the four main columns on form 3 enter the block designations, A, B, C, and D, as shown. Then, from form 2 take the number of the row in which treatment no. 1 was planted in each block, and enter it under the designation of that block on form 3. In like manner prepare forms for treatments 2, 3, etc. (see page 17).

For most efficient field work in re-examination, go first to row 1 in block A. Take the sheets (form 3) for all 20 treatments (or whatever the number is) and arrange them in numerical order according to the row numbers entered in the first main column, under the heading "Block A." Go down row 1, entering the condition, etc., of each tree opposite the tree number on form 3. Tree 1 in row 1 should be in the far, left-hand corner of the block as it is approached from the road or gate, as suggested on page 3 and in figure 1. A measuring stick may help to speed up the work if survival is low or if the trees are hard to find in the grass; in extreme cases it may save time to stretch the original measuring string along the row. Since exactly 25 trees were planted in the row, the list of trees living, dead, or missing must total 25 in the corresponding column on form 3.

When the main column for row 1 of block A has been filled in, replace the form 3 for that row with the one for row 2, move over one space in the plantation to row 2, and enter the record for that row on its form. It is not necessary to walk back to the no. 1 tree in row 2; the row can be run in reverse by starting at the bottom of the main column on form 3, opposite tree no. 25, and working upward on the form.

2/ Form 3, originated by C. F. Olsen, Assistant Silviculturist, Southern Forest Experiment Station, is essentially a mechanical means of "unrandomizing" the randomized rows for purposes of re-examination and averaging. The reduction in cost and in errors resulting from its use in an important factor in making the method of randomized balanced blocks feasible for extensive studies of survival in forest planting.

When the last (for example, the 20th) row in block A has been examined, in each of the 20 forms the first, or left-hand, main column will be filled in, and the other three main columns will be blank. The next step is to arrange the 20 forms in numerical order, based on the row numbers in the second main column, for block B. When this has been done, proceed with the examination of block B as with block A, and repeat for blocks C and D.

For the sake of uniformity in accuracy and judgment, it is best to have one man re-examine all the trees in one study. In the case of very large studies, or of great numbers of studies, it may be necessary to work with several assistants. If four assistants are used, one might be given the first five rows on each block, the second the next five, and so on. By giving the same man the same portion of each successive block, slight differences in accuracy and judgment are "averaged out" by the random arrangement of treatments, just as are slight differences in soil within each block. Gross differences in accuracy and judgment, however, can not be tolerated.

Form 3, as given, provides for records of vigor and injury, as well as of survival. Such records, if carefully taken, may add greatly to the value of the study, and their inclusion tends to increase the accuracy of the survival counts. At the bottom of form 3 are shown symbols (capital letters for condition and vigor, small letters for injuries) found useful by the Southern Forest Experiment Station; other symbols may be added as needed. It must be remembered, however, that the plantation has been established primarily to study survival. All other information is of secondary importance, and form 3 may therefore be simplified by omitting all "vigor" and "injury" columns and retaining merely a "condition" column for each block.

Analysis and Summary of Results

Since each treatment has been tested by planting 100 trees (25 per treatment per block), the total number of living trees recorded on form 3 for that treatment constitutes the survival percentage.

The survival percentages for the various treatments may be entered along the right-hand margin of form 2, or summarized or tabulated in any other manner desired. The ideal procedure is to make an analysis of variance and to test the significance of the differences between the survival percentages of different treatments, 3/ but this requires both extra time and

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3/ This method of analysis was first used by Fisher and is presented in: Fisher, R. A. Statistical methods for research workers. Ed. 5, rev. and enl. 319 pp., illus. London. 1934.

For an elementary description of the analyses, see:

Bruce, Donald, and Schumacher, Francis X. Forest mensuration. 360 pp., illus. [Part II.] New York and London. 1935.

Snedecor, George W. Calculation and interpretation of analysis of variance and covariance. 96 pp., 35 tables. Monograph No. 1. Division of Industrial Science, Iowa State College. Collegiate Press, Inc., Ames, Iowa. 1934.

Tippett, L. H. C. The methods of statistics. 222 pp., illus. [Chs. VI and X.] London. 1931.

considerable familiarity with statistical technique.

It should be emphasized, however, that these elaborate statistical analyses merely measure and describe the precision and reliability of the results, and are useful only because they show what the odds are that the observed differences in survival are the result of the treatments and not of chance. The precision and reliability have already been attained by the randomization of treatments within balanced blocks, and are there whether measured and described or not. In other words, the man establishing an experimental plantation may be assured that differences in survival shown by several treatments tested according to the methods here described reveal the relative value of the treatments much more clearly than they would if each treatment had been confined to one 100-tree row running across the entire planting site.

The principle involved can be illustrated very simply. Suppose 20 treatments are being tested, by means of 100 trees each, planted in a rectangular block in which there is an evident decrease in soil quality from north to south. The careful experimenter presumably would have his rows run north and south, so that some of the trees in each row would fall on good soil and some on poor. Suppose, however, that for the width of one or two rows along the west edge of the plot there is a strip of soil that appears to the eye to be like the rest, but is actually much more favorable to initial survival. If each treatment is confined to a single row running the length of the plot, the one or two rows falling on the strip of good soil will show an initial survival out of all proportion to the merits of the treatments tested in those rows. But if the plot is divided into four equal blocks, each 25 trees long, and the treatments are rearranged at random in each block, the odds are very small that any one treatment will fall on the strip of good soil in all four blocks. If it falls elsewhere, even in only one block, the average survival of that treatment is decreased, and the average survival of the treatment that replaces it on the good soil is increased, thus reducing the differences in average survival arising solely from soil fertility. The principle that applies in the case of such a narrow strip of favorable soil applies equally to soil or other variations of any other size or shape.

Summary of Precautions

To aid in avoiding delay or errors in establishing survival studies, the following precautions are summarized in the order in which the need for them is likely to occur:

1. Have clearly in mind the kind and number of treatments to be tested, being sure that all those in one study may be legitimately compared or contrasted.

2. Record the description of each treatment in writing, so that the successful treatments can be unquestionably duplicated and the unsuccessful ones avoided in later practice.

3. Before beginning actual installation, obtain lotto numbers, a receptacle for shaking, a supply of forms, the required number of marking strings, and the necessary corner posts and row stakes.

4. In laying out the plantation, take every reasonable precaution to have uniform conditions throughout each individual block.

5. If unavoidable differences occur over the planting area as a whole, lay out the blocks so that the greatest differences occur between one block and another, and the least possible differences within any one block.

6. Keep blocks fairly close together, each preferably within 100 feet of the next, if not actually adjoining.

7. Mark the blocks with durable posts, plainly labeled, before planting; the blocks should also be mapped for the office record.

8. Stake the rows before planting.

9. Number the rows systematically, preferably as shown on page 3 and in figure 1.

10. In randomizing treatments over block diagrams (form 1), mix the lotto numbers very thoroughly, and draw, list, and retain the numbers as they come, without bias, laying each number aside as drawn.

11. Check forms 1 and 2 against each other before beginning planting.

12. Plant the entire study in one day (unless it is a study of weather-on-day-of-planting, or of date-of-planting). Do not start work if rain threatens to prevent completion.

13. Use one planter or pair of planters for the entire study, if the study is small enough for them to complete in one day. If it is too large for this and more men must be used, be sure that each block is planted by the same man (or pair) throughout. Within any one block never have one species or treatment planted by one man, and another by another man.

14. Be careful not to introduce any disturbing factors, such as using seedlings of one seed source or date of sowing for one treatment and of a different source or date for another; exposing part of the stock in treatment no. 1 to a much longer period of drying than the rest; or dipping part of the stock in water and planting the rest without dipping. In the example cited on pages 4, 13, and 15, the "fresh checks" for the storage study must also be baled and heeled-in, if only for a minute, lest they benefit from less handling as well as from prompter planting than the other stock.

15. Before leaving the planting site, be absolutely sure that the records on forms 1 and 2 agree with the location of the treatments on the ground.

16. Before beginning re-examinations, check all copies of form 3 for accuracy of species, treatment, and block and row designations.

17. In re-examining any one block, be particularly careful to avoid entering data for two rows on the same sheet of paper. Take a new sheet for each new row of trees.

18. In running from the high-numbered to the low-numbered end of the row, remember to begin at the bottom of the corresponding column on form 3.

19. Allow plenty of time for re-examination and thus avoid careless inaccuracies. Search thoroughly before calling a tree "B" (=missing, or blank). If this work is entrusted to subordinates, be sure that they are adequately trained and instructed, and check their work by examining a number of rows without letting them know which rows you are going to check.

20. Be sure that every form (1, 2, or 3) includes the name or description of the study (including species), the season of establishment, the date the form was filled in, and the name or initials of the man responsible for the accuracy of the data.

SAMPLE FORM 1. ESTABLISHMENT REPORT DIAGRAM

Block A. Study: Test of method and duration of storage of slash pine planting stock

Planted by____________________ on______________, 193_.

Supervised by____________________________

Row No.	Treatment No.	Nature of treatment
1	19	Heeled-in, then taken up and planted immediately
2	1	Heel-in 5 days
3	15	Heel-in 40 days
4	17	Heel-in 45 days
5	16	Bale 40 days
6	3	Heel-in 10 days
7	2	Bale 5 days
8	18	Bale 45 days
9	6	Bale 15 days
10	13	Heel-in 35 days
11	10	Bale 25 days
12	9	Heel-in 25 days
13	5	Heel-in 15 days
14	11	Heel-in 30 days
15	12	Bale 30 days
16	8	Bale 20 days
17	4	Bale 10 days
18	7	Heel-in 20 days
19	14	Bale 35 days
20	20	Baled, then unpacked and planted immediately

SAMPLE FORM 2. ESTABLISHMENT REPORT SUMMARY

Study: Test of method and duration of storage of slash pine nursery stock

Established by_________________________ on________________, 193_.

Treatment No.	Nature of treatment	Row occupied by treatment in block: A	B	C	D
1	Heel-in 5 days	2	17	18	11
2	Bale 5 days	7	4	17	etc.
3	Heel-in 10 days	6	20	etc.	
4	Bale 10 days	17	etc.	etc.	
5	Heel-in 15 days	13	etc.		
6	Bale 15 days	9			
7	Heel-in 20 days	18			
8	Bale 20 days	16			
9	Heel-in 25 days	12			
10	Bale 25 days	11			
11	Heel-in 30 days	14			
12	Bale 30 days	15			
13	Heel-in 35 days	10			
14	Bale 35 days	19			
15	Heel-in 40 days	3			
16	Bale 40 days	5			
17	Heel-in 45 days	4			
18	Bale 45 days	8			
19	Heeled-in, then taken up and planted immediately	1			
20	Baled, then unpacked and planted immediately	20			

SAMPLE FORM 3. FIELD EXAMINATION RECORD

Study: Test of method and duration of storage of slash pine planting stock

Established by____________________ on____________________, 193_.

Re-examined by____________________ on____________________, 193_.

Species: Slash pine   Nature of treatment: No. 1 Heel-in 5 days

Tree No.	Block A Row No. 2			Block B Row No. 17			Block C Row No. 18			Block D Row No. 11			Notes
	Condition	Vigor	Injury by	Condition	Vigor	Injury by	Condition	Vigor	Injury by	Condition	Vigor	Injury by	
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													
Totals													

SYMBOLS

Condition
- L = living
- D = dead
- B = blank (missing)

Vigor
- T_1 = very thrifty
- T_2 = thrifty
- G_1 = growing
- G_2 = growing poorly
- F_1 = failing
- F_2 = almost dead

Cause of injury
- a = ants
- e = erosion
- d = drought
- f = fungi
- g = gophers
- i = insects (not ants)
- p = poor planting
- r = rabbits
- s = silting

Figure 1. Diagram of storage study plantation described in text, showing location of first 175 trees planted.